2.80 inches; and the fifth, 2.55 inches. The average for the entire period totaled 2.39 inches. Converting these differences to percentages again, we have the following: 11, 7, 9, 14, and 12, and the average for the period 11 per cent.

A difference of 10 per cent in the actual amount of rainfall would be a very important matter in the semiarid sections of the West.

Since the following study corroborates what others have found out in the past as regards the difference in catch between ground-exposed and elevated gages, it must be admitted that the Weather Bureau is doing the proper thing by insisting that rain gages should be located on the ground whenever it is at all possible, so that uniform records may be obtained.

Monthly catch of precipitation

GROUND-EXPOSED GAGE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924	------	------	------	------	------	------	------	------	------	0.60	1.04	1.95
1925	0.44	0.62	1.39	4.67	1.87	6.86	3.45	1.08	4.50	4.20	1.19	0.28
1926	1.15	1.74	2.10	2.79	3.37	2.55	2.53	3.64	6.93	6.04	1.40	0.87
1927	0.75	0.63	4.74	6.41	2.83	8.62	7.00	7.08	3.41	2.62	0.73	0.67
1928	0.03	2.30	0.57	2.67	2.84	5.77	3.55	6.13	2.27	1.68	6.97	1.35
1929	2.51	1.32	2.02	5.24	6.49	4.34	1.91	2.69	2.11	------	------	------
Means	0.98	1.32	2.16	4.36	3.48	5.63	3.69	4.12	3.84	3.03	2.27	1.02

ROOF-EXPOSED GAGE

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1924	------	------	------	------	------	------	------	------	------	0.66	0.88	2.16
1925	0.28	0.55	1.15	4.40	1.92	6 05	3.44	0.87	3.57	3.28	1.12	0.19
1926	1.12	1.39	2.06	2.71	3.01	2.49	2.42	3.27	6.40	4.90	1.42	0.97
1927	0.73	0.76	5.31	5.10	2.69	8.19	6.23	6.80	3.44	3.05	0.72	0.78
1928	0.02	2.43	0.53	2.69	2.46	5.11	2.75	4.91	2.51	1.47	6.08	1.24
1929	2.42	1.26	2.01	5.26	5.96	3.18	1.70	2.64	1.49	------	------	------
Means	0.91	1.28	2.21	4.03	3.21	5.00	3.31	3.70	3.48	2.67	2.04	1.07

Annual catch of precipitation

[Year, October to September, inclusive]

	Ground-exposed gage	Roof-exposed gage	Difference in catch	Difference in catch
YEAR	*Inches*	*Inches*	*Inches*	*Per cent*
First	28.47	25.93	2.54	10
Second	32.47	29.46	3.01	10
Third	49.78	46.54	3.24	7
Fourth	30.15	27.96	2.19	8
Fifth	38.63	34.71	3.92	11
Means	35.90	32.92	2.98	9

CATCH DURING THE WINTER SEASON

[Season, October to March, inclusive]

SEASON				
First	6.04	5.68	0.36	6
Second	10.66	9.16	1.50	16
Third	14.43	14.09	0.34	2
Fourth	6.92	7.53	−0.61	−8
Fifth	15.85	14.48	1.37	9
Means	10.78	10.19	0.59	6

CATCH DURING GROWING SEASON

[Season, April to September, inclusive]

SEASON				
First	22.43	20.25	2.18	11
Second	21.81	20.30	1.51	7
Third	35.35	32.45	2.90	9
Fourth	23.23	20.43	2.80	14
Fifth	22.78	20.23	2.55	12
Means	25.12	22.73	2.39	11

A FACTOR IN THE TEMPERATURE OF THE STRATOSPHERE

551.524 : 551.510.5

By W. J. HUMPHREYS

When we first heard, some 30 years ago, that the temperature of the air rather rapidly decreases with increase of height up to the level of the highest currus, or wispy, clouds, and from there on as far as a balloon could carry a thermometer remains practically constant, we just didn't believe it—not all of it. We accepted, of course, the first part of the statement to the effect that the greater the height the colder the air. We had gotten used to that from mountain climbing and from the records kept by balloonists. Then, too, we had found a good physical reason why it should be so, or at any rate an essential part of that reason. It is this: Ascending air expands, because the pressure on it grows less and less by the weight of the air left below, but it expands against the weight of the air that still is above it, and therefore does work. Now, to do work it must expend energy, and its available energy for this purpose is its heat. Evidently then, ascending air, expanding as it goes, and doing work at the expense of its own heat, must get colder and colder with increase of height. All this is in perfect accord with our laboratory experiments, and so we accepted the fact of the decrease of temperature with increase of height as a phenomenon which, if not entirely selfevident, at least is so easy to explain as scarcely to merit a passing thought.

That is where we made at least two mistakes. In the first place, even when it does occur it isn't half so easy to explain as we thought it was, and, in the second place, it doesn't occur at all in the high atmosphere. Of course the pressure continuously decreases with gain of level beyond the highest clouds, just as it does below them, and so asking us to believe that the temperature does not also decrease up there with increase of level just as it does in the cloud region was asking too much; it was contrary to our laboratory experience. However, after hundreds of records obtained by sounding balloons (small balloons carrying only registering instruments) had shown that immediately the uppermost cloud level is passed the temperature really is practically constant, why of course we had to accept it as a fact, and revise our explanations accordingly.

In the end it all came out simply enough. Our previous reasoning had been perfectly correct, but the premises were sadly deficient. We had left out of account the effects of radiation, and had set no limit to convection. Throughout all that portion of the atmosphere in which clouds of any kind occur, that is, from the surface up to the height of 6 to 7 miles, in middle latitutes, and 8 to 10 miles in tropical regions, there is decided convection—change in level of individual masses of air. The temperature, therefore, of each such mass does vary with height, and as the whole of this portion of the atmosphere is involved in this continuous vertical turnover so also does this temperature relation extend to its every portion. But beyond the clouds vertical convection, if it exists at all, is so slow as to be practically absent so far as temperature effects are concerned. Here no one portion of the air changes temperature with altitude for the good and sufficient reason that it neither rises nor falls. Heat is not added to it by compression, nor taken from it by expansion. It therefore comes to that particular temperature at which it can lose heat by radiation at exactly the same rate that it gains heat by absorption. From this level up the intensity of the radiation from the earth and atmosphere below is practically independent of height. That is why temperature up there also is independent of height. It doesn't change appreciably even from day to night, and so we infer that it is not much affected by sunshine directly.

Thus again we had come to that state of mental ease that goeth with understanding. But the ease was of short duration. It soon was found that the upper air, the stratosphere, as scientists now call it, is coldest over equatorial regions and becomes gradually warmer with increase of latitude, the extreme difference being around 35° F.—coldest over the warmest earth and warmest over the coldest earth. Here was a poser, and we are not through trying to explain it yet. And now they (certain scientists) tell us that up beyond the highest reach of our balloons there is ozone in the very thin air. Well, that is what we would expect from the fact that ozone is produced whenever a certain portion of ultra-violet radiation falls on oxygen. But botheration again! There seems to be least ozone over tropical regions, where we would expect most, and more and more with increase of distance from the equator, and not less and less. Well, this isn't explained yet either, but we can make use of it, and that is what we propose now to do.

Ozone is a powerful absorber of the long wave-length radiation that goes out from the earth and its water-soaked atmosphere. Furthermore, whatever quantity of radiation the ozone absorbs, that same quantity, changed in part to other wave lengths, it must reradiate, otherwise it clearly would do what obviously it is not doing, that is, continuously get either warmer or colder. Now, as the radiation by the ozone evidently is as much in one direction as another, half of it is back towards the lower atmosphere. It also is evident that where there is least ozone the percentage of absorption and reradiation also is least, and as the quantity of the ozone increases so also does this percentage of return radiation. In short, one reason (not the only one) why the stratosphere becomes colder and colder as we go from high latitudes to the Equator, is because the ozone blanket at the same time grows thinner. It is a little like sleeping warmly outdoors under a quilt or shivering under a sheet—lots depends on the kind and quantity of covering one has.

ICE STORM OF DECEMBER 17–18, 1929, AT BUFFALO, N. Y.

551.578.4 (747)

By J. H. SPENCER, Weather Bureau

On the morning weather map of December 17, 1929, pressure was high along the Canadian border and to the northward, while a moderate LOW extended from the southern part of the upper Lake region southwestwardly to Oklahoma and northern Texas. Light north to east winds resulted in the Lake region. The striking feature on the weather map of this date was the fact that moderate to heavy rains were falling over the southern half of the Lake region, with temperature below the freezing point at the surface. The temperature at 8 a. m. at Buffalo, for instance, was 26°, rain falling at the time. Rain continued throughout the day and most of the night, exceeding an inch.

Part of the heavy rain at Buffalo froze as it fell, or soon after, making streets and sidewalks very slippery and dangerous, but sloppy above the ice in many sections. Practically all the time that rain fell the temperature was below freezing. The resulting ice storm of Tuesday and Tuesday night, December 17, was one of the worst of record here. Hundreds of street trees were severely damaged. The weight of the ice Tuesday night was at least double that which resulted from the ice storm of December 7 and 8. Tree branches the size of an ordinary lead pencil were enlarged by the ice to the thickness of 1 to 1½ inches. Thousands of limbs as large as one's arm were broken off by the weight of the ice, great damage resulting.

ICE ON BRANCHES

Forsythia branch.—Length, 1 yard 4 inches. No lateral twigs. Total weight, with ice, 1⅛ pounds; without ice, ⅜ ounce. Greatest diameter of ice, 1¼ inch to full 1½ inch. Slightly uneven, due to buds at 2 to 3 inch intervals. Top diameter of ice was 1 inch and narrowing to a knife blade at bottom. (See fig. 1.)

Thickness of ice above wood, about ⅞ inch; below wood, ¼ to ⅜ inch. Weight of wood, ⅜ ounce. Diameter of wood alone, ⅛ inch at small end and ¼ inch at large end. Ice coating was as thick at one end as at the other.

Elm branches.—From one large limb lying on the street I broke off four tips, each about 15 inches long, and with lateral twigs, without disturbing the ice. Collectively they weighed, with ice, 2½ pounds; without ice, 3 ounces.

One ornamental tree in my yard, as large as a full-grown fruit tree, was completely broken down. I broke off a tip 28 inches long, with lateral twigs, from one branch; weight, with ice, 1½ pounds; without ice, 1 ounce. It was impossible to see between the icy branches of this tree; that is, one could not see the street or any object on the other side of the tree, so heavy was the ice on the limbs.

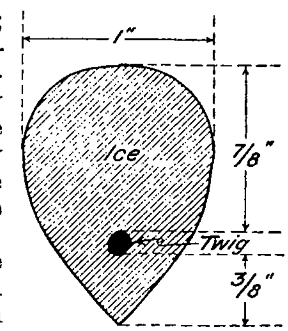

FIGURE 1

After these measurements were made, I brought the ice-covered branches into a warm room, with temperature of 70°, and it took more than two hours for the ice to melt away sufficiently for it to break away from the wood. This illustrates roughly how difficult it is in a cold climate to get rid of the ice before it does great damage merely by remaining on objects for many hours and often days after the ice storm occurs.

AFTER THE ICE STORM

Cold weather, with temperature below freezing, and without sunshine, continued through December 18, 19, and 20. Ice remained as heavy on trees and wires as on the night of the 17th and 18th. On the 19th there was more than an inch of sleet (very small ice pellets that looked, in the aggregate, like snow, but of great weight). Following this, a 50-mile gale blew most of the time for 24 hours, beginning soon after 8 a. m. of the 20th; and on the night of the 20th and 21st there was a 6-inch fall of snow, which drifted badly. These long-continued severe conditions caused great damage and much hardship in the Buffalo district and throughout western New York.